Maximizing the benefits of Li-ion systems for PV hybrid microgrids

thanks to field experience and modelling expertise

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Intersolar Europe 2014 – BSW Off-Grid Power Forum

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Maximizing the benefits of Li-ion systems for PV hybrid microgrids

thanks to field experience and modelling expertise

1. Overview of the PV Hybrid Microgrid application

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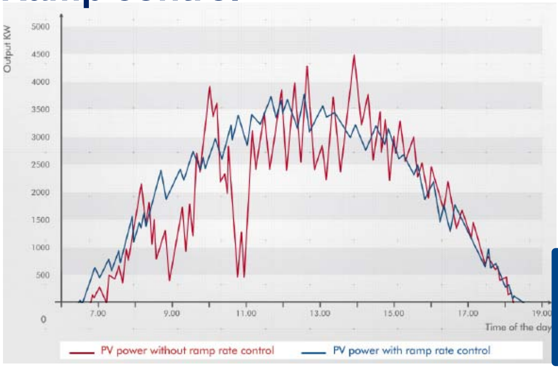
PV Hybrid Microgrid application

Source SMA

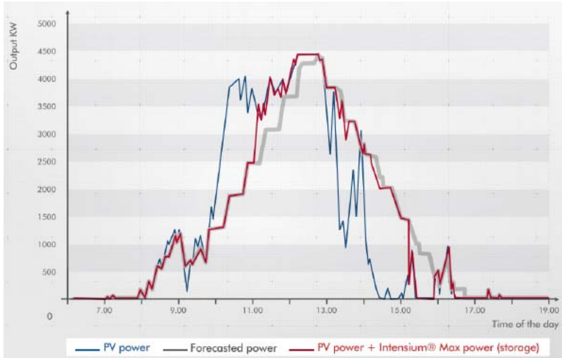
2. Typical storage applications within PV-Hybrid-Microgrid

Typical storage applications for PV Integration

Ramp control



Smoothing output to forecast

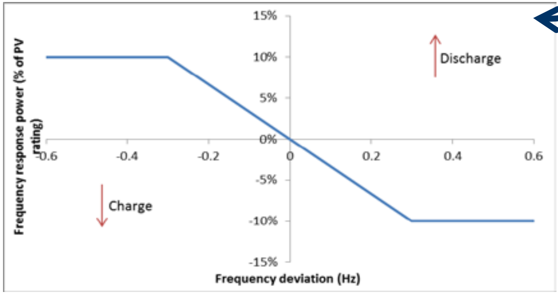


What Benefit?

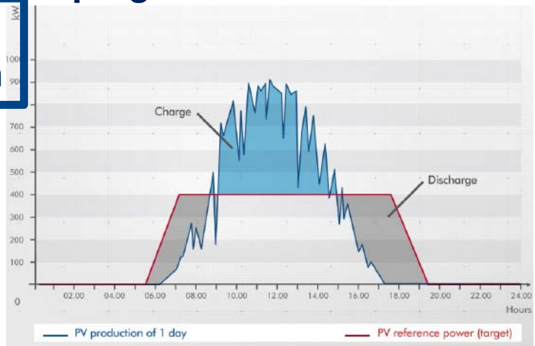
Fuel Save

Higher PV penetratrion

Frequency Regulation / Spinning reserve substitution



Shaping



3. Return of experience on the typical storage applications

Installed base of Utility Scale containerized ESS

In partnership with: acciona Energía

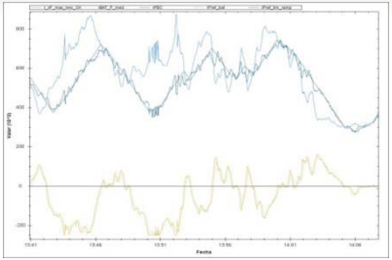
ILIS Project (Tudela, Spain)

- First European PV + Battery MW plant connected to mainland grid
- Associates **1,2MWp PV plant** and **560kWh - 1,1MW IM20M storage**
- 4 modes of operation: 1 - defined P & Q setpoints; 2 - ramp rate control; 3 - frequency regulation; 4 - voltage regulation
- Acciona control system able to adapt to different Grid Codes and to offer ancillary services based on hourly PV production predictions, meterogical data, electricity price estimation

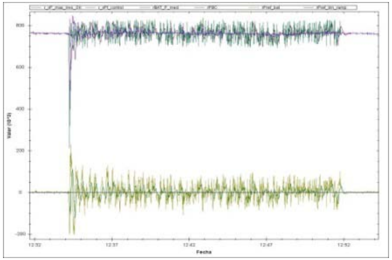
Operational
March 2012

ILIS Tudela Operation modes

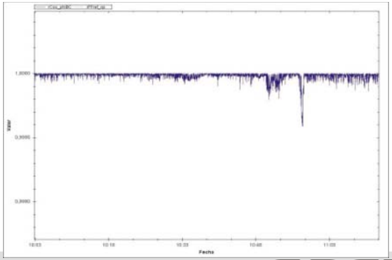
- **Ramp rate control:** fluctuations in active power can be regulated according pre-defined maximum ramp rates depending on set parameters and grid operator setpoints



- **Frequency regulation**: active power production of the plant is regulated based on grid frequency.
  - Battery power +/-200kW (20% of Pmax)
  - Accuracy +/-10%
  - **Time response with PCS 0,5 Sec**



- **Reactive power control**: three working modes are possible: plant cos phi control regulation, voltage regulation at grid connection point or Q setpoint from operator



In partnership with:

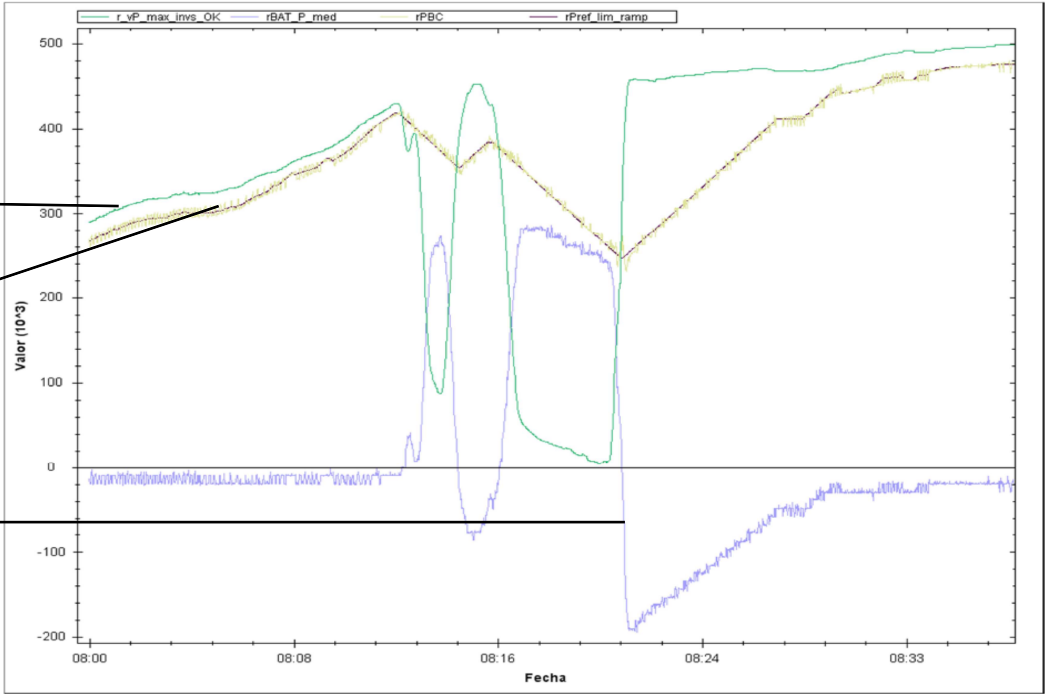
ILIS Tudela Operation modes

Active power ramp control +/- 2.5% / min

PV generation

Ramp controlled output

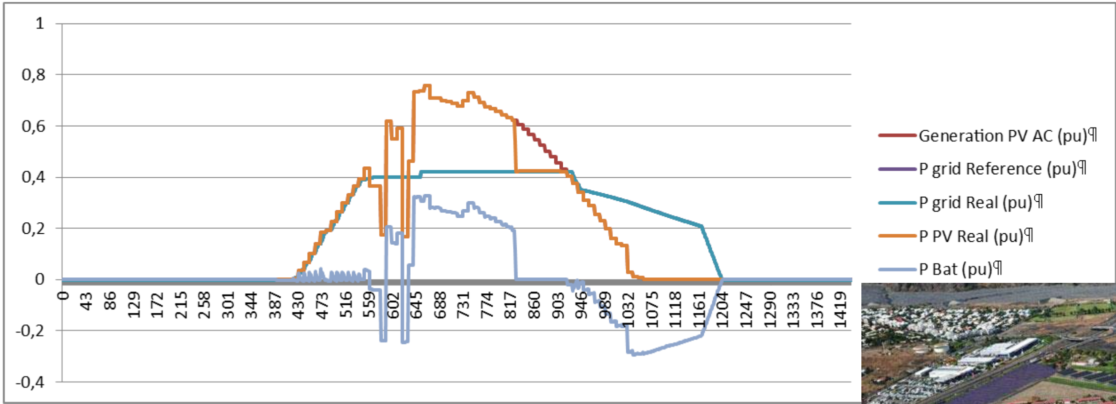
Battery charge/discharge



Shaping application in La Réunion Island

Bardzour project (La Réunion Island)

- Project with **EDF/SEI** and **Akuo Energy**
- **9MWp PV Plant** and **9MWh** containerized storage system for Shaping



Operational
2014

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PV ramp control + frequency control in Puerto-Rico

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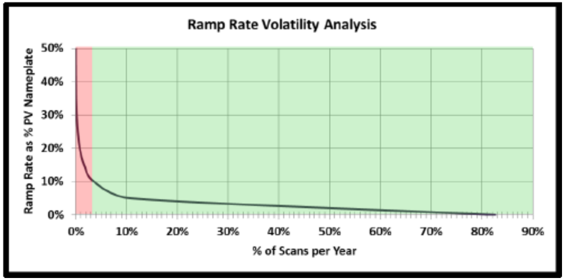
Salinas 10MWp PV Power plant in Puerto Rico

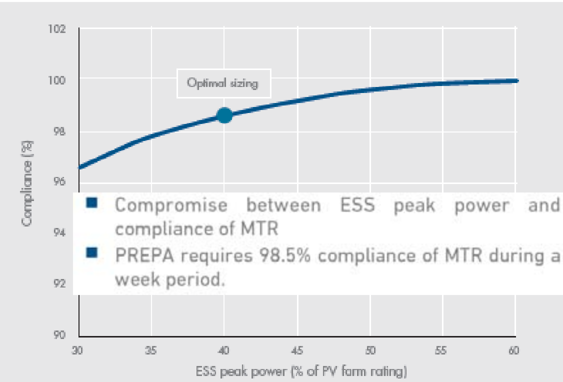
Requirements

PREPA Requirements Meet
10% smooth ramp-rate control, Frequency Response w. 5% droop & 10% major frequency response (9mins)



Source APER

Arbitraging the sizing options



- Compromise between ESS peak power and compliance of MTR
- PREPA requires 98.5% compliance of MTR during a week period.

The chosen solution

PV Farm	Building blocks
10MW	3x (IM20P+PCS)

1,3MWh
up to 4C
e.g. 5 MW

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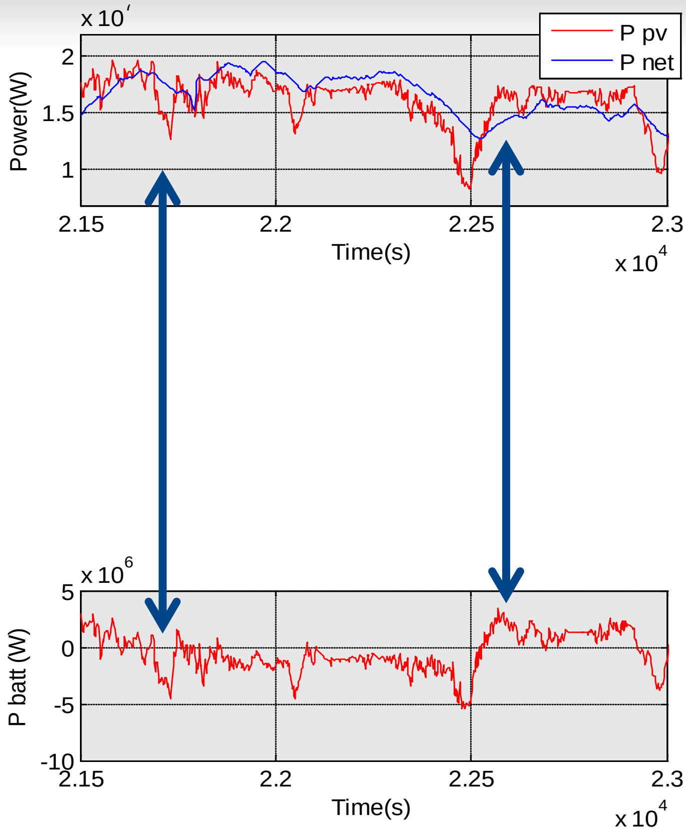
PV ramp control + frequency control in Salinas

PV generation power

Fed-in power



Battery power:

Up to 5MW discharge

4. The Power of Modelling

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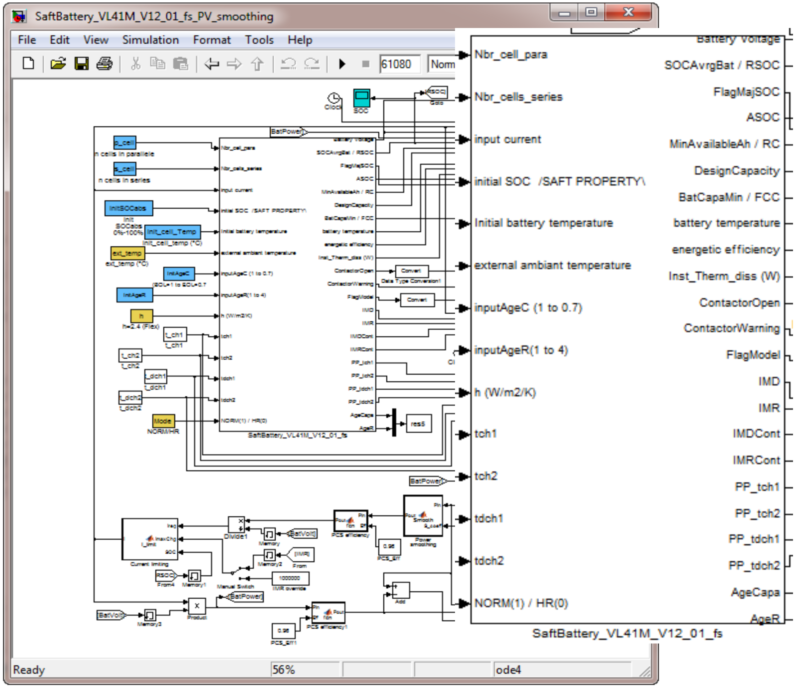
Modelling the battery system: a long-term process

- Long-term systematic characterization of the target technology in a large variety of use profiles with focus on:
  - Electrical
  - Thermal behavior
  - Ageing
- Develop performance and ageing models
- Extensive validation
- Models Used for battery sizing and aging analyses

Overview of a model used at Saft



- Models run same algorithms as battery management systems
- Model will run a project load-profile
- Exactly mimic real battery behavior, including contactor management
- Possible to build alternative “what if” scenarios

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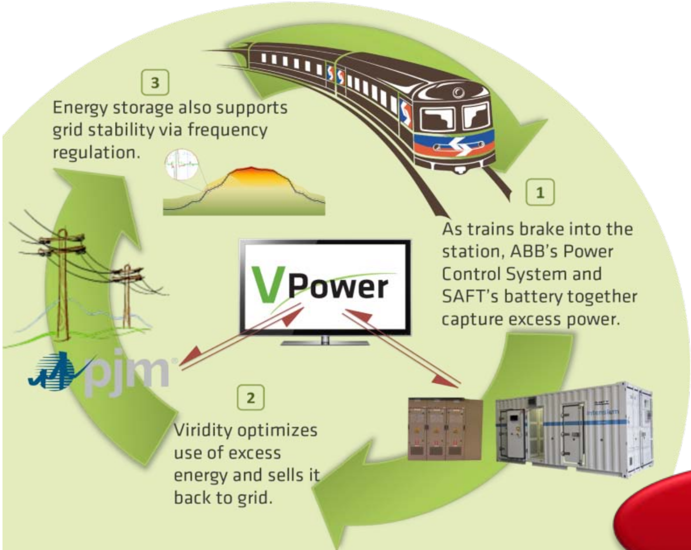
Benefits of Modelling at SEPTA – Philadelphia (USA)

Energy Storage, Regen, and Energy Markets…

…an Industry First

- INTENSIUM ® Max 20P container (1,5 MW)
- Partnering with Envitech (ABB)

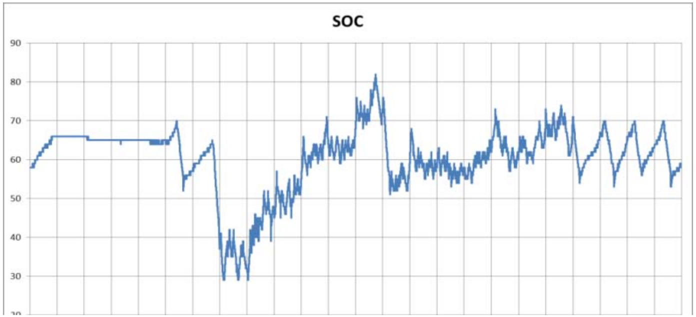
- Customer: SEPTA
  - > **Brake energy recovery from trains**
  - > **Injection during train acceleration**
- Grid Services by Viridity to PJM
  - >**Participation in frequency regulation markets**



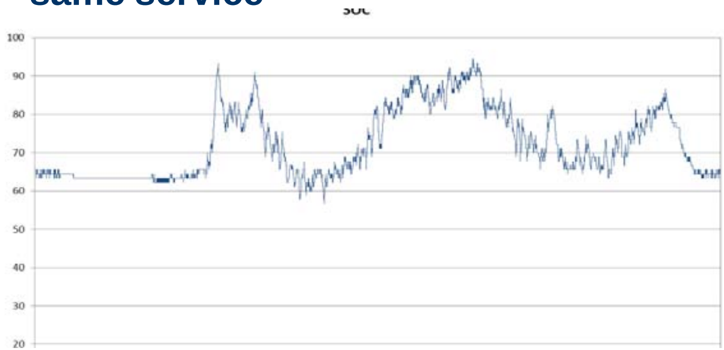
Operational
Feb 2012

SEPTA system SOC management – optimization based on real data

The base case



Optimized battery management for same service



Original SOC management strategy involved frequent SOC swings

- Aging per year: **~5%**
- Daily energy throughput: **1.8 MWh**

Optimized SOC management strategy with narrower SOC target band

- Aging per year: **~2%**
- Daily energy throughput: **2.2 MWh**

Same Service → **Life time : X 2**
Energy throughput : +20%

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5. Lessons learned and conclusions

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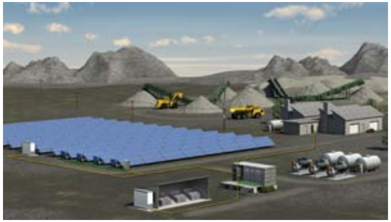
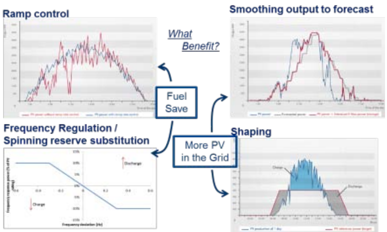
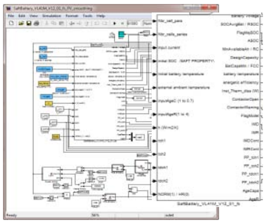
Lessons learned and conclusions







- PV Hybrid Microgrids are a new playground for Energy Storage Systems
- Li-ion storage systems power versatility benefits have been demonstrated in operation
- Key-factor of success for bankable business case is advanced battery modelling:
  - Consistent and trustworthy technical assements
  - Sizing optimization at pre-project phase
  - Service performance and lifetime optimization during operation phase

Thank you !

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